



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Nuclear Energy Advanced Modeling & Simulation (NEAMS)

Some Questions and a Few Answers

Alex R. Larzelere
NE-54



Why?

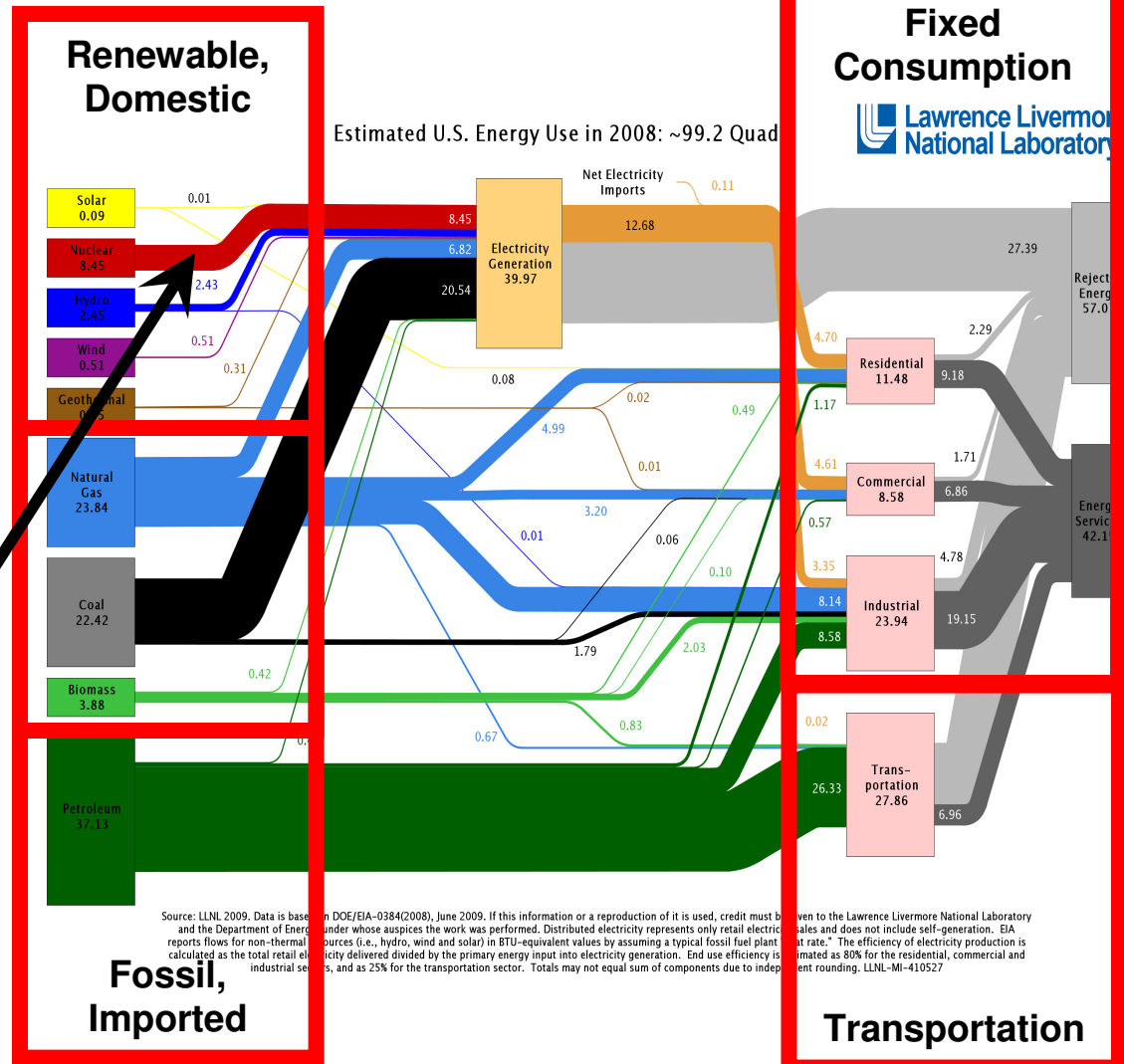
Nuclear Energy

■ Elements U.S. Energy Security

- **National Security**
 - Avoiding dependence on unreliable sources
- **Economic Security**
 - Assured supplies at affordable prices
- **Environmental Security**
 - Obtaining and using energy in ways that do not harm the environment

■ Improving Energy Security requires advances in all domestic, clean, and reliable forms of energy

- Biomass
- Geothermal
- Wind
- Solar
- Conservation
- and . . . **Nuclear**





U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

What is the role of advanced modeling and simulation?

National Goals for Nuclear Energy Technology Development

- Decrease costs
- Improve performance
- Increase pace of deployment
- Enhance innovation
- Responsively deal with nuclear waste
- Promote non-proliferation

■ We need to go beyond traditional “test-based” approach to understanding nuclear energy

- Very successful for over last 40 years – current fleet is very safe and performs well
- However, test-based approach is:
 - Very slow
 - Very costly
 - Very hard to optimize

■ Development, deployment and use of advanced modeling and simulation will:

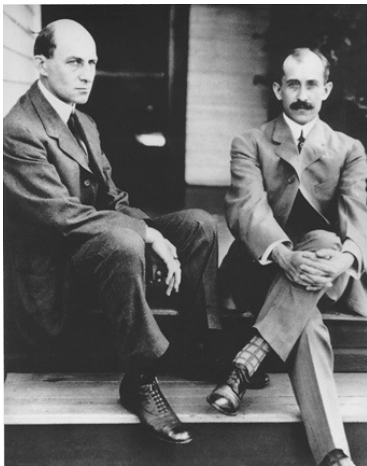
- Provide a new means of obtaining science-based insight that will
 - Increase the pace of innovation
 - Reduce costs by eliminating unnecessary margins
 - Optimize operations
 - Reduce uncertainty and risk



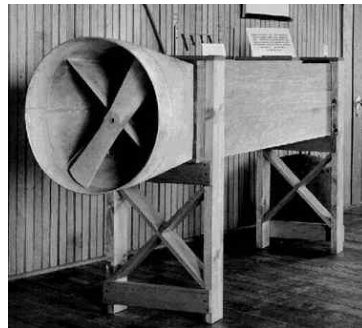
U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

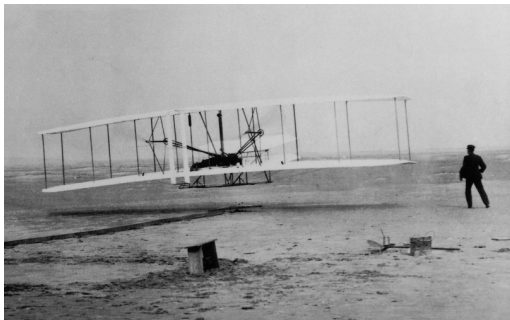
Why did these guys fly?



1901 Wind Tunnel



These guys invented this



Before they did this
in 1903

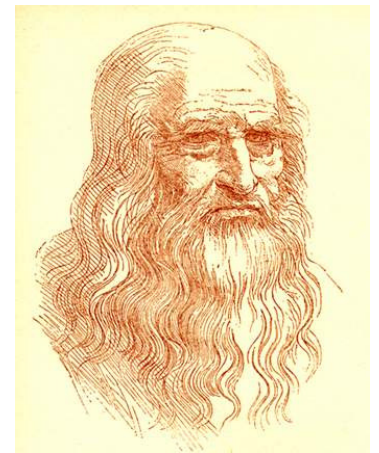
**Modeling
and
Simulation
is in the
wind tunnel
invention
business.**

Nuclear Energy Advanced Modeling and Simulation

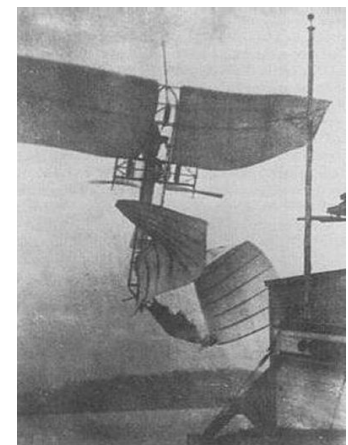
When this guy could not?



This guy spent his
time studying birds.



And his airplane looked
like this.

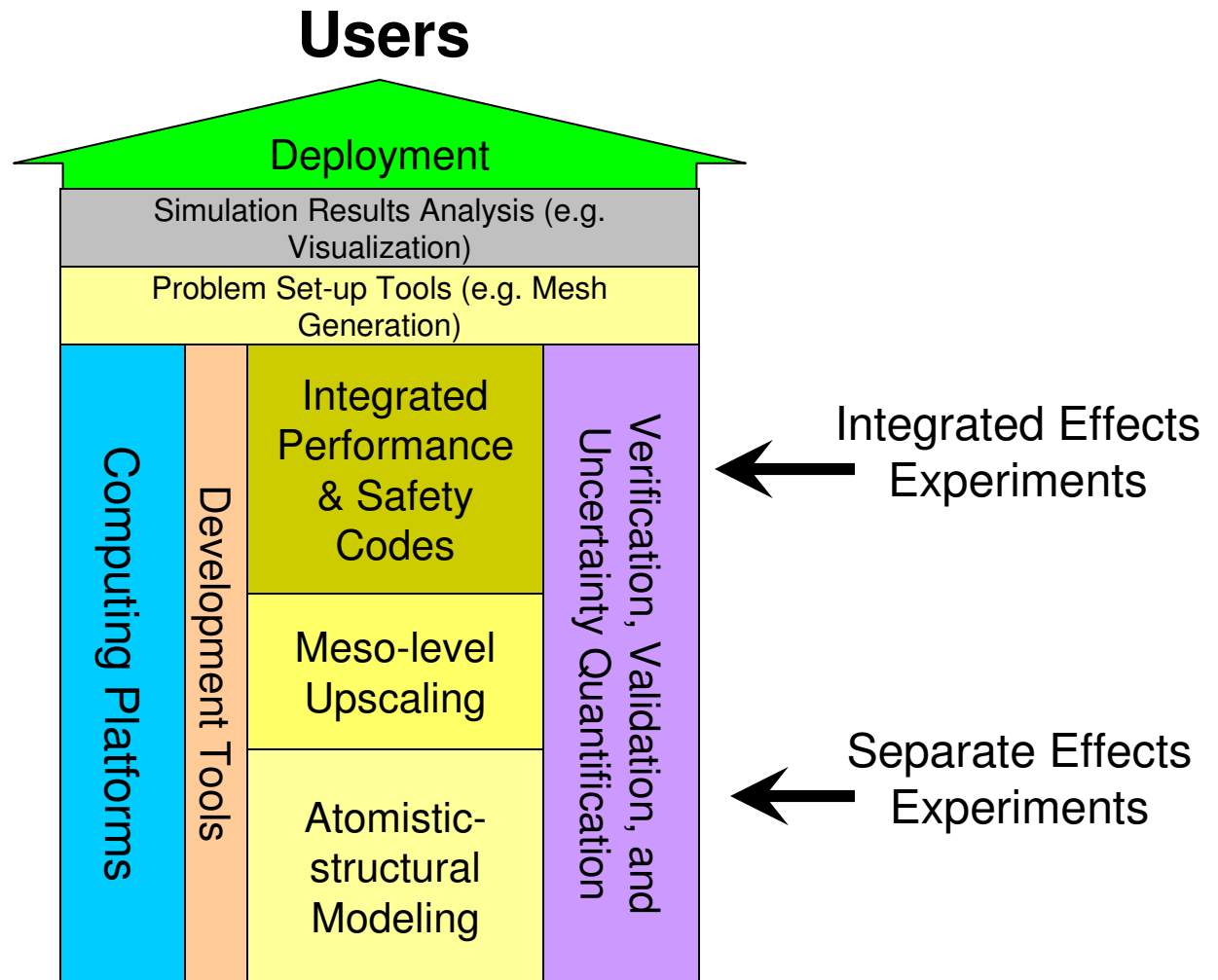


But flew like this.



What will our wind tunnel look like?

Note: An advanced modeling and simulation program does not have to build all of the elements. However, it must ensure that all of the elements exist and are integrated in order to build advanced capabilities





Who are we doing this for?

■ Research and Development

- To make discoveries and obtain insight into the physical behavior of nuclear energy technologies (e.g. reactors, fuels, waste)

■ Technology Designers

- To conduct design studies for new nuclear energy technologies to understand performance, safety, and cost with the potential of a design of a system submitted for licensing.

■ Regulators

- To evaluate submitted designs and supporting analysis to determine if the technologies will meet the requirements to protect human health and the environment

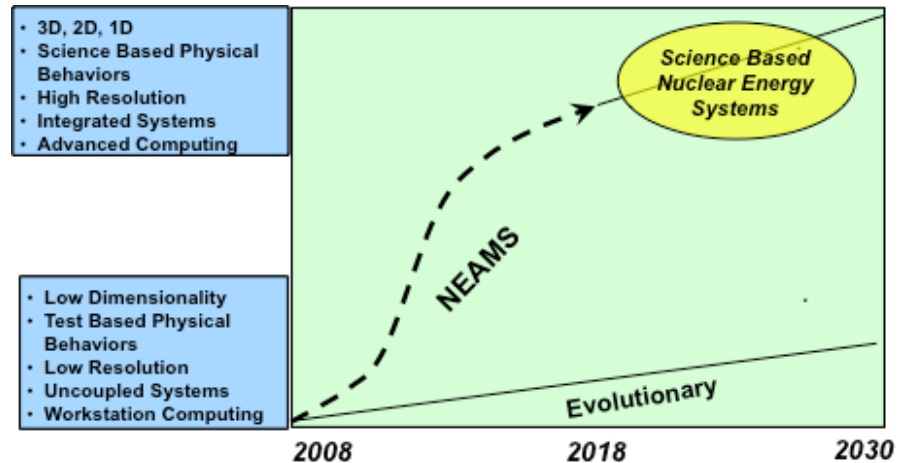
■ Utilities & Operators

- To understand and optimize the operations of nuclear energy technologies



How will NEAMS do it?

- **Continuously increasing capability for predictive simulation of the performance and safety of:**
 - Nuclear reactors
 - Fuels
 - Safeguarded Separations
 - Waste Forms in a Repository Environment
- **These capabilities will be flexible so they can be applied to difference types of nuclear energy technologies**
- **NEAMS will implement a comprehensive approach that ensures that new capabilities are fully developed and “born” with appropriate verification, validation and uncertainty quantification.**



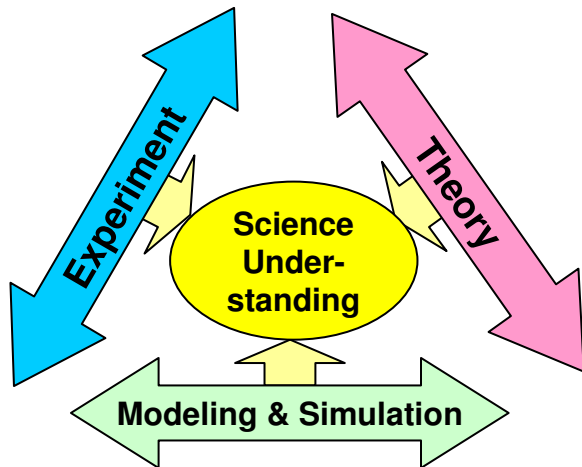
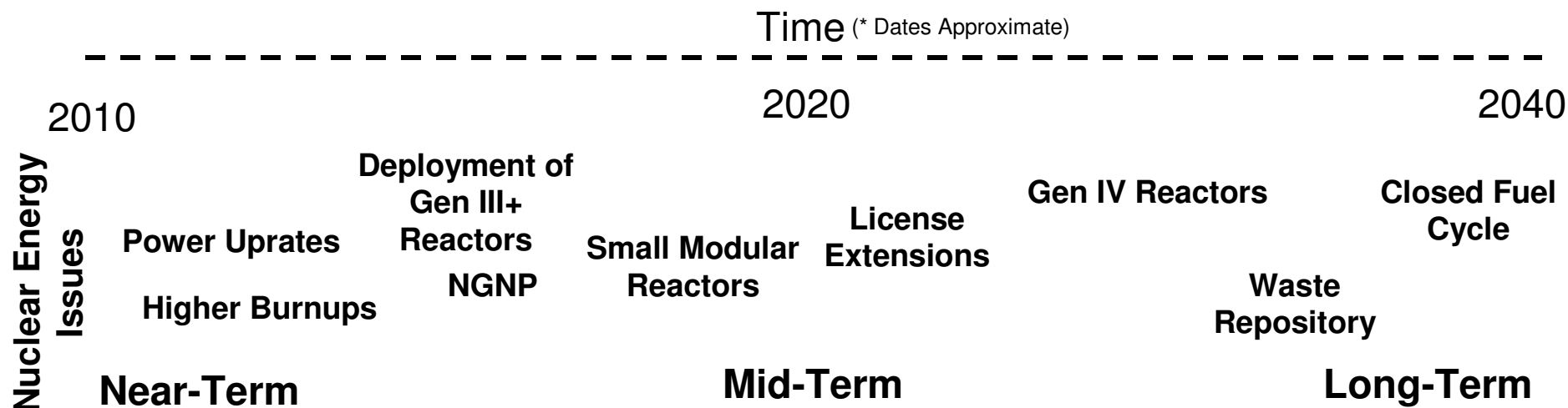
- **Modeling and simulation capabilities that can be used to create scientific understanding, design, and license nuclear energy technologies for:**
 - Sustainment of the current LWR fleet
 - Near term deployment of new advanced reactors
 - Innovative uses of nuclear energy
 - Proper disposal of waste
 - Closing the fuel cycle



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

What is the role of the Hub?



**New Ways of Understanding
Nuclear Energy**

**Modeling and simulation
has become a peer to theory
and experiment to develop
science insight**

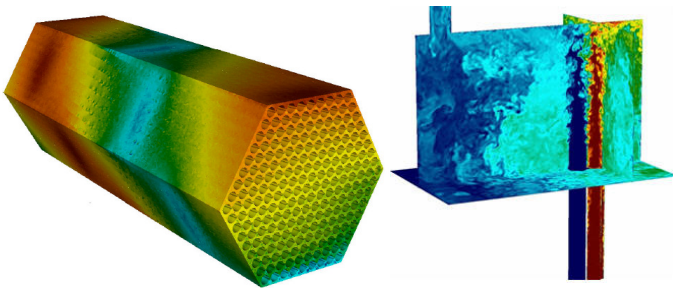


U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

How Can the NE Modeling and Simulation (M&S) Hub Change the Game?

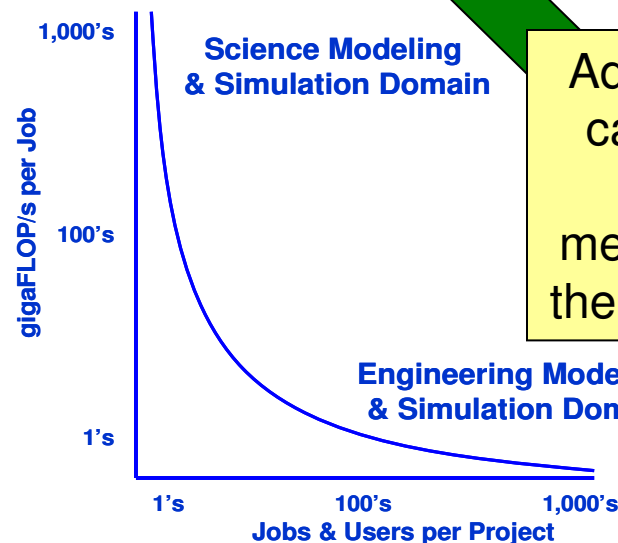
Existing Advanced Modeling and Simulation Capabilities



Change the Game by
Accelerating the Use of
Advanced Modeling and
Simulation to Address Near
Term Nuclear Energy Issues

Currently in the Science Domain

- Few users
- Few jobs
- Very big computers/job
- Long runtime



Adapt **Science Domain** capabilities to address issues for the near, medium and long term in the **Engineering Domain**

Engineering analysis is different

- Short, high pressure timelines
- Requirement for many, short jobs
- Many users
- User environment straightforward

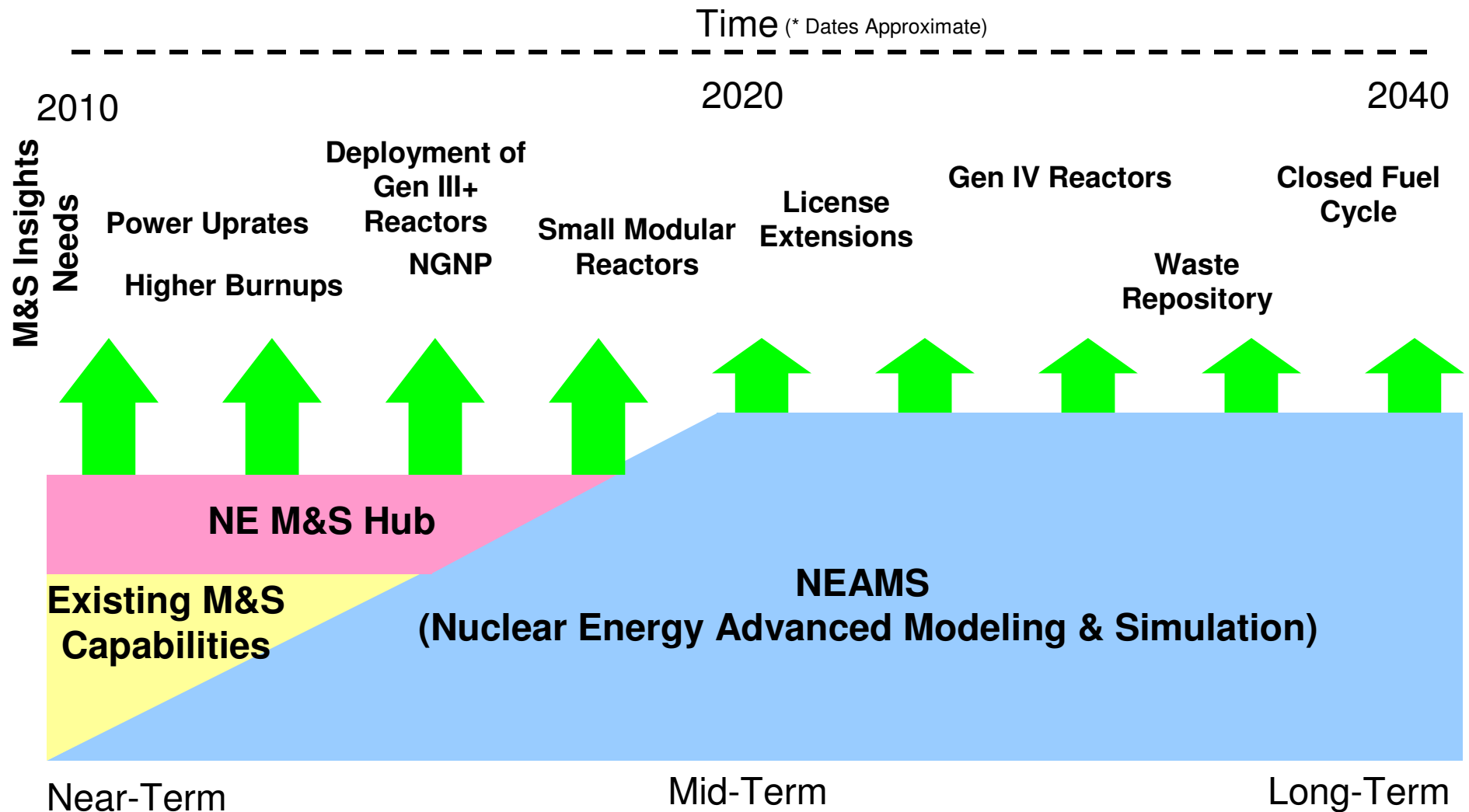
DRAFT



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

What is the role of the Hub?





U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

What is the role of PI Meetings?

- **To build and strengthen the NEAMS community**
 - To help researchers to understand how their projects fit into the overall NEAMS pictures
 - To have an open discussion about projects and conduct scientific and engineering reviews
 - To encourage collaborations between labs, universities, industry, other parts of DOE, and other agencies

- **To communicate NEAMS accomplishments, work, and plans to outsiders**

- **There will be two major NEAMS meeting each year**
 - One (like this) focused on an overall review of activities & accomplishments
 - Another (break-out style) for detail discussions and planning



PI Meeting Agenda – Day 1

Wednesday - September 30, 2009

Time	Topic	Presenter
8:00	Continental Breakfast	
8:30	Welcome and Introductions	Alex Larzelere
9:15	NEAMS Overview	Andrew Siegel
9:45	Reactor Integrated Performance and Safety Code (IPSC) Overview & Strategy	Tim Tautges
10:15	Break	
10:30	Reactor #1: Advanced Thermal Modeling Code Development	Paul Fischer
11:15	Reactor #2: Advanced Neutron Transport Simulations	Won Sik Yang
12:00	Lunch – DOE Cafeteria	
1:00	Reactor #3: Initial Coupling of High Fidelity and Integral Analysis Methods	Tom Fanning
1:45	Nuclear Fuels IPSC Overview & Strategy	Cetin Unal
2:15	Break	
2:30	Fuels #1: IPSC Code Status	John Turner
3:15	Fuels #2: A Constitutive Law for Cladding that Links Length Scales and Validation Through State of the art VU	Carlos Tome
4:00	Fuels #3: Overview of Metallic Fuel Modeling Activities at ANL	A. Yacout
4:45	Wrap-up	Alex Larzelere
5:00	Adjourn	

7:00 NEAMS PI Meeting Dinner – Held at Golden Bull, Gaithersburg



PI Meeting Agenda – Day 2

Thursday – October 1, 2009

Time	Topic	Presenter
8:00	Continental Breakfast	
8:30	Welcome and Summary from Tuesday	Alex Larzelere / Andrew Siegel
8:45	Fundamental Methods and Models Overview and Strategy	Moe Khaleel
9:15	FMM #1: Mesoscale simulation of fission gas transport phenomena	Veena Tikare
10:00	Break	
10:15	FMM #2: Microstructure Evolution Modeling and Thermal Mechanical Property Predictions	Xin Sun
11:00	FMM #3: Multi-scale Models and Methods for Nuclear Materials: Hierarchical Multi-scale Modeling	Hamid Garemstani
11:45	Waste IPSC Overview and Strategy	John Mitchiner
12:15	Lunch – DOE Cafeteria	
1:15	Waste #1: Use Cases, PIRT, and System Design	Carter Edwards/ Geoff Freeze
2:00	Waste #2: Atomistic to Continuum Upscaling and Application to Glass Corrosion Modeling	Peter Schultz & Carl Steefel
2:45	Break	
3:00	Verification, Validation and Uncertainty Quantification Overview and Strategy	Jim Stewart
3:45	Reactor Neutronics Simulation Demo	Giuseppe Palmiotti
4:30	Fuels Simulation Sensitivity Analysis and A Method to Predict Value of Obtaining More Data	Cetin Unal
5:15	Enhanced Verification Methods	Jim Stewart
6:00	Wrap-up	Alex Larzelere & Andrew Siegel
6:30	Adjourn	



PI Meeting Agenda – Day 3

Friday – October 2, 2009

Time	Topic	Presenter
8:00	Continental Breakfast	
8:30	Welcome and Summery from Tuesday	Alex Larzelere/ Andrew Siegel
8:45	SafeSeps IPSC Overview and Strategy	Scott Demuth
9:15	SafeSeps #1: Multi-tiered Separations Process Modeling	Valmor de Almeida
9:45	Break	
10:00	SafeSeps #2: Multi-scale Simulation of Solvent Extraction Processes"	Kent Wardle
10:30	SafeSeps #3: Enhanced Solution Safeguards through Modeling and Simulation	Michael Collins
11:00	Capability Transfer Overview and Strategy	Gil Weigand
11:20	CT #1: Experience with High Fidelity Modeling using Saturne and the Salome Framework	John Magerlein
11:40	CT #2: Towards a Software Architecture and Framework for the NEAMS Program	David Bernholdt
12:20	Lunch – DOE Cafeteria	
1:20	Enabling Computational Technologies Overview and Strategy	Lori Diachin
1:50	ECT #1: Visualization and Analysis activities for NEAMS	Hank Childs and Mark Miller
2:20	Break	
2:45	ECT #2: Risk Based Software Quality Analysis Approach	Greg Pope
3:15	Identification of NEAMS Issues and Strategy Adjustments	Alex Larzelere & Andrew Siegel
4:00	Adjourn	



Logistics

■ Questions & Discussion

- Please use the handheld mikes
- Please introduce yourself and organization the 1st time

■ Rest Rooms

- Upstairs from the lobby

■ Badges

- Wear at all times
- Those without DOE badges need to get site passes

■ Lunches

- On your own
 - DOE Cafeteria
 - Off-site

■ PI Meeting Dinner

- Wednesday Evening
 - 6:30 cash bar
 - 7:00 dinner
- Golden Bull Grand Café –
- 7 Dalamar St, Gaithersburg, MD 20877-2501
- <http://www.golden-bull.com/>
- \$33.00 per person, please pay Dan Vega

■ Network Connectivity

- Yeah right – remember we are at DOE